CRUSH PROTECTION FOR AN OPENABLE MOTOR VEHICLE ROOF

[0001] This invention relates to an openable motor vehicle roof with a movable roof element for selectively closing and at least partially clearing a roof opening, a body-mounted frame component which extends over at least one edge area of the roof opening, a seal element which is located in the area of the frame component, and against which the roof element rests when the roof opening is being closed, an electric motor drive for moving the roof element, and a monitoring means which is coupled to the drive and which evaluates the drive parameters derived from the drive and turns off and optionally reverses the drive when it is recognized using the evaluation of the drive parameters that there is a interfering body between the roof element and the edge area of the roof opening.

[0002] In motor vehicles, for closing elements, especially electrically actuated windows, automatically closing doors or electrically activated rooves, which are actuated by an outside force, two types of crush protection devices are used, as is explained for example in EP 0 870 892.

[0003] In one type of crush protection, pressure-actuated sensor elements are used which are provided on one closing edge and which when exposed to pressure turn off or reverse the drive of the closing element. In another type of crush protection information about possible crushing is taken from the power data of the drive unit for the closing element. In particular, the motor current tapped on the drive or the torque delivered by the drive motor can be monitored, and both rise in the case of crushing. Furthermore, via evaluation of the motor revolutions and/or rpm of the drive the position and/or speed information can be evaluated with respect to the adjustable roof element in order to implement obstacle detection. If predetermined boundary values of the respectively interrogated parameters are not reached or are exceeded, the drive unit is turned off and optionally the direction of motion is reversed.

[0004] Especially for motor vehicle rooves in which the movable roof element at the end of its closing motion rests against a seal element, crush protection of the latter type often cannot be reliably implemented since the change of the drive parameters caused by the crushed interfering body is superimposed on the change of the drive parameters which is caused by the

deformation of the seal element. Especially for motor vehicle rooves in which the roof element for closing the roof opening pivots from overhead against the body-mounted frame, as is the case for example for externally guided sliding rooves but also for convertible rooves, the problem moreover arises that the roof element strikes the interfering body at a relatively acute angle so that the interfering body does not abruptly block the motion of the roof element, but rather leads to gradual jamming of the roof element; this is not necessarily interpreted as crushing of the interfering body by the monitoring means which is coupled to the drive.

[0005] The object of this invention is to devise a motor vehicle roof of the initially mentioned type which more reliably recognizes the presence of the interfering bodies than existing crush protection devices and with which especially smaller crushed bodies are more reliably recognized.

[0006] In a motor vehicle roof of the initially mentioned type, this is achieved as claimed in the invention in that on the roof element there is a stop surface for detecting an interfering body and that the motor vehicle roof is made such that if there is a interfering body between the edge area of the roof opening and the roof element when the roof opening is being closed, the stop surface comes into contact with the interfering body before the roof element engages the seal element. Because the stop surface of the roof element comes into contact with the interfering body before the roof element engages the seal element, the increase of the force caused by driving of the roof element as a result of the crushing of the interfering body can be clearly distinguished from the increase of force caused by compression of the seal. This is especially advantageous for small interfering bodies in which the roof element compresses the seal more strongly before the interfering body can cause the drive to be turned off.

[0007] Preferred configurations of the invention will become apparent from the dependent claims.

[0008] In particular, this invention is used in motor vehicle rooves in which when the roof opening is being closed the motion of the roof element has a component perpendicular to the roof surface, especially for those in which the roof element rests from obliquely overhead against the seal element when the roof opening is being closed. In these motor vehicle rooves the seal element accepts relatively great deformation since it must produce not only the compressive force for making available a sealing action, but also must allow the pivoting-in

motion of the roof element. Therefore, especially for these motor vehicle rooves it can happen that the interfering body is immersed into the sealing element so that when the roof element is being closed the change of the drive parameters caused by the deformation of the seal element is superimposed with the signal change caused by the roof element striking the interfering body. Examples of these motor vehicle roofs are especially externally guided sliding rooves (so-called ASD rooves), spoiler rooves and convertible rooves.

[0009] Preferably the stop surface in the direction of the closing motion of the roof element projects above the roof element. This results in that the stop surface strikes the interfering body at an obtuse angle so that a clear increase of force is achieved on the drive which can be clearly recognized by the monitoring means.

[0010] The stop surface can be made especially as an edge which projects in the area of the front edge of the roof element. In particular the stop surface can be made as an extension of the front edge of the roof element in the direction of the closing motion of the roof element.

[0011] The production cost of the motor vehicle roof as claimed in the invention can be minimized when the stop surface is simply foamed onto the roof element. In particular, when the roof element has peripheral edge foaming, for example when the roof element is the transparent cover of a glass roof, the stop surface can be integrated into the peripheral edge foaming so that it is produced at the same time without an additional working step by suitable shaping of the foaming tool when the roof element is foamed.

[0012] Preferably the motor vehicle roof is designed to detect interfering bodies up to a thickness of up to 4 mm or less, measured in the closing direction of the roof element. Advantageously the motor vehicle roof is made here such that without making available additional crush protection systems which work with sensors, crushed bodies can be reliably detected as is prescribed in current safety standards, especially in US standard FMVSS 118 and EU Guidelines 74/60, 2000/4 and ECE R21.

[0013] As in the known crush protection devices, the monitoring means can be furthermore designed to detect the current consumed by the electric motor drive, the torque delivered by the drive, the number and direction of revolutions of the driven shaft of the drive, the rpm of the drive and/or the positioning speed of the roof element. The detected drive

parameters can then be compared to given setpoints in order to stop or reverse the drive when the respective setpoint is exceeded or not reached.

[0014] Preferred embodiments of the invention are detailed below with reference to the attached drawings.

Figure 1 shows a schematic perspective front view of a motor vehicle roof with the cover closed;

Figure 2 shows the representation as shown in Figure 1 with the cover completely opened;

Figure 3 shows a section through the front edge of the motor vehicle roof as claimed in the invention with an interfering body crushed;

Figure 4 shows a section similar to Figure 3 through a motor vehicle roof according to the prior art, and

Figures 5 to 7 show modified embodiments of the motor vehicle roof as shown in Figure 3.

[0015] The motor vehicle roof 10 shown in Figure 1 comprises a wind deflector louver 14 which is pivotally located above the windshield 12, a movable cover 16 which is located behind this wind deflector louver 14, and a fixed roof pane 18 which adjoins the closed cover 16. Laterally the wind deflector louver 14, the cover 16 and the roof pane 18 are each bounded by a side member 20.

[0016] In the closed state as shown in Figure 1, the motor vehicle roof 10 offers a completely smooth appearance. Although the cover 16 can be moved to the rear over the fixed roof pane 18 (see Figure 2) to clear the roof opening 22, guides located above the fixed vehicle roof 10 are not necessary for this purpose. To raise and move the cover 18 to the rear, the cover 18 is supported rather by means of laterally coupled support levers 26 which can be moved in guides located below the level of the fixed roof skin and which upon emergence to the top partially displace a flexible seal element 28 which is located between the side members and the components 14, 16, and 18. As shown in Figure 2, the cover 18 is raised over the fixed roof surface 18 to clear the roof opening 22 with its rear edge 24. The opening size for the roof opening 22 is maximum when the cover 16 moreover is also raised with its front edge 30 over the level of the fixed roof surface.

[0017] Figure 3 shows a section through the motor vehicle roof as shown in Figure 1 in the area of the front edge of the roof opening 22. Figure 3 shows one embodiment in which instead of the raisable wind deflector louver 14 there is a window element 32, with a roof frame 34 surrounding the roof opening 22 being connected to its underside. In this connection, along the front edge of the roof opening 22 there is a seal element 36 in the roof frame 34 against which the cover 16 rests when the roof opening 22 is being closed. As is indicated by the broken line 42 in Figure 3, the front edge 38 of the cover 16 moves on a path which is directed obliquely down with reference to the fixed roof surface when the cover rests against the seal 36.

[0018] Furthermore Figure 3 shows a test bar 38 by means of which crushing of an article between the front edge 30 of the cover and the front edge of the roof opening 22 is simulated when the cover 16 is being closed. Figure 3 shows the state in which the test bar 38 is pressed by the front edge 30 of the cover 16 against the fixed roof frame 34 and is completely immersed into the seal 36 in doing so. Since in this state the drive parameters of the electrically driven cover 16 clearly change, especially the torque delivered by the motor, the motor current delivered by the drive motor and the motor revolutions and the rpm of the drive, a monitoring means coupled to the drive of the cover 16 can detect crushing, stop the drive and initiate reversal of motion of the cover 16 in order to release the test bar 38 again. As can furthermore be seen in Figure 3, on the underside of the front edge 30 of the cover 16 there is a stop surface 40 in the form of a projection which projects in the direction of the closing motion of the cover 16, i.e. along the broken line 42. The manner of action of the projection 40 is detailed below using Figure 4 which shows a view similar to Figure 3 of a known motor vehicle roof.

[0019] In the conventional roof as shown in Figure 4, the cover 16 is made as a component which is flat with the exception of a bulge 44 to which the support levers for raising the cover are connected, and which rests against the seal 36 when swivelling into the roof opening 2 with the underside of its front edge. If in such a roof there is a test piece or a crushed body in the area of the front edge of the roof opening, such a crushed body, especially when it is relatively small, cannot be reliably detected by the drive of the cover 16. This can be attributed on the one hand to the motion of the front edge of the cover which is pointed obliquely down, and which tries to yield to the front when it strikes the test bar 38, i.e. to slide onto the test bar. Due to the sliding increase of the crushing force, an insufficient reaction on the electric motor

drive which could be detected by the crush protection system takes place. It is even more serious that for a relatively small crushed body the front edge 30 of the cover 16 strikes the seal 36 and deforms it before it strikes the test bar 38. Therefore the increase of force which can be established on the drive and which is caused by the unintentional crushing of a crushed body cannot be clearly distinguished from the braking of the cover caused in normal undisrupted operation of the motor vehicle roof when plunging into the seal 36.

[0020] This invention devises a remedy here in a very simple, but extremely effective manner by, as shown in Figure 3, there being on the cover 16 for detecting the interfering body 38 a stop surface 40 which comes into contact with the interfering body 38 before the cover 16 engages the sealing element 36. Depending on the geometry of the frame 34 and the seal 36 small crushed bodies 38 can be detected by the corresponding configuration of the projection 40. In order to prevent the stop surface from sliding onto the test piece 38, as is the case in existing rooves (see Figure 4), the stop surface 40 is preferably arranged such that it projects in the direction of the closing motion 42 of the cover 16 so that it strikes the test piece 38 at an angle as oblique as possible.

[0021] Versions of the stop surface 40 are shown in Figures 5, 6 and 7 in views similar to Figure 3. Preferably the stop surface 40 is made in one piece with the front edge 30 of the cover 16. This can be easily accomplished especially for covers which have peripheral foaming for example of PU foam by suitable shaping of the foaming tool.

[0022] With the concept proposed here, especially also smaller crushed bodies which were often not correctly detected by existing crush protection systems, can be detected. By earlier detection accomplished by means of the stop surface, moreover the reliability of the system is increased. The concept proposed here is especially suited for use in motor vehicle rooves in which a movable roof element is placed from overhead or from obliquely overhead against a seal element, such as for example for externally guided sliding rooves (ASD rooves). Making available relatively expensive direct crush protection systems which operate with sensors can thus be circumvented by a relatively simple geometrical configuration of the front edge of the cover.

Reference number list

10	motor vehicle roof
12	windshield
14	wind deflector louver
16	cover
18	fixed roof pane
20	side member
22	roof opening
24	rear edge of 16
26	support lever
28	sealing element
30	front edge of 16
32	front fixed element
34	roof frame
36	seal element
38	test piece
40	projection
42	path of motion of 30
44	coupling point for the raising lever